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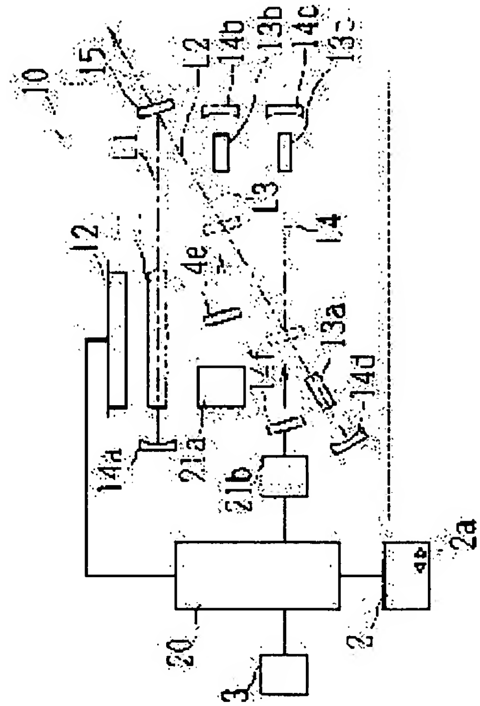
(54) LASER EQUIPMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide laser equipment which can effectively output a plurality of laser beams which are different in wavelength while alignment precision is easily ensured when wavelength is changed.
SOLUTION: Laser equipment which can output a plurality of laser beams which are different in wavelength is provided with an exciting light source, solid-state laser medium which outputs a plurality of peak wavelengths by a beam from the exciting light source, a first resonance optical system which is used for oscillating a second harmonic wave having a first peak wavelength out of peak wavelengths outputted from the solid-state laser medium, as a first laser beam, a movable reflecting mirror which is inserted in and extracted from a part between the solid-state laser medium arranged in the first resonance optical system and a first wavelength converting element, and a second resonance optical system which commonly uses a resonance optical path on the solid-state laser medium side in the first resonance optical system by inserting the movable reflecting mirror in the optical path and is used for oscillating a second harmonic wave having a second peak wavelength which is different from the first peak wavelength outputted from the solid-state laser medium, as a second laser beam.



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CLAIMS

[Claim(s)]
[Claim 1] The laser beam of the wavelength from which plurality differs is set to the laser equipment in which outgoing radiation is possible. The excitation light source, While resonating the 1st peak wavelength of the peak wavelength emitted from the solid-state-laser medium which emits two or more peak wavelength by the light from this excitation light source, and this solid-state-laser medium The 1st resonance optical system with the 1st wave sensing element for oscillating the second harmonic of the 1st peak wavelength as the 1st laser beam, The movable reflective mirror the optical path between said solid-state-laser media and 1st wave sensing elements which have been arranged at this 1st resonance optical system inserts [mirror], While sharing the resonance optical path by the side of said solid-state-laser medium in said 1st resonance optical system by insertion to the optical path of this movable reflective mirror Laser equipment characterized by having the 2nd resonance optical system with the 2nd wave sensing element for oscillating the second harmonic of the 2nd different peak wavelength from said 1st peak wavelength emitted from a solid-state-laser medium as the 2nd laser beam.
[Claim 2] Laser equipment characterized by having arranged the output mirror which has the property which penetrates the wavelength of said 1st laser beam and the 2nd laser beam while reflecting said 1st and 2nd peak wavelength in the laser equipment of claim 1 in the optical path of the 1st resonance optical system shared with said 2nd resonance optical system.
[Claim 3] It is laser equipment characterized by said solid-state-laser medium using the crystal of Nd:YAG in the laser equipment of claim 2.
[Claim 4] The laser beam of the wavelength from which plurality differs is set to the laser equipment in which outgoing radiation is possible. The excitation light source, While having the resonance mirror of the pair which resonates the 1st peak wavelength of the peak wavelength emitted from the solid-state-laser medium which emits two or more peak wavelength by the light from this excitation light source, and this solid-state-laser medium The 1st resonance optical system with the 1st wave sensing element for oscillating the second harmonic of the 1st peak wavelength as the 1st laser beam, The movable reflective mirror which is a movable reflective mirror put on the 1st location and 2nd location possible [a change] in the optical path between said solid-state-laser media and 1st wave sensing elements, and constitutes said 1st resonance optical system when switched to the 1st location, While sharing the resonance optical path by the side of said solid-state-laser medium of said 1st resonance optical system When said movable reflective mirror is switched to the 2nd location The second harmonic of the resonance mirror which is the 2nd resonance optical system by which the resonance optical path of dedication was formed in the reflective direction, and resonates the 2nd different peak wavelength from said 1st peak wavelength emitted to this exclusive optical path from said solid-state-laser medium, and said 2nd peak wavelength is made into the 2nd laser beam. Laser equipment characterized by having the 2nd resonance optical system by which the 2nd wave sensing element for oscillating has been arranged.
[Claim 5] It is laser equipment characterized by to be established the exclusive optical path of said 1st and 2nd resonance optical system, respectively in the reflective direction of said drive reflective mirror in which it is the movable reflective mirror switched to said the 1st location and 2nd location, and a location is switched by this migration by being moved said movable reflective mirror in the laser equipment of claim 4 in the direction of said solid-state-laser medium of a resonance optical axis.
[Claim 6] the laser equipment to which said movable reflective mirror is the movable reflective mirror switched to said the 1st location and 2nd location by rotating to the circumference of the shaft of the shaft which intersects perpendicularly with the resonance optical axis of said solid-state-laser medium in the laser equipment of claim 4, and a location is characterized in the reflective direction of a change ****** drive reflective mirror by this rotation by ****** in which the exclusive optical path of said 1st and 2nd resonance optical system is prepared, respectively.
[Claim 7] In the laser equipment of claim 4, when the resonance optical path of said 1st resonance optical system

inserts, said movable reflective mirror It is the movable reflective mirror switched to said the 1st location and 2nd location. Laser equipment characterized by forming the exclusive optical path of said 2nd resonance optical system in the reflective direction when said 1st resonance optical system is constituted when removed from the resonance optical path of said 1st resonance optical system, and a movable reflective mirror is inserted in the resonance optical path of said 1st resonance optical system.
[Claim 8] Laser equipment characterized by having arranged the output mirror which has the property which penetrates the wavelength of said 1st laser beam and the 2nd laser beam while reflecting said 1st and 2nd peak wavelength in which laser equipment of claims 4-7 in the optical path between said solid-state-laser medium and said drive reflective mirror.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the laser equipment which can choose the laser beam of two or more wavelength, and can be oscillated.
[0002]
[Description of the Prior Art] Argon die laser with the wavelength of a laser beam strange good as laser equipment in which outgoing radiation is possible, the krypton laser of multi-wave length, etc. are known in the laser beam of the wavelength from which plurality differs. These are used in various fields, such as the medical fields, such as an ophthalmology operation from which the wavelength for which it is suitable for the affected part or the therapy purpose differs. for example, the therapy of the disease (affected part) which changes with differences in wavelength (color) centering on a visible region in an ophthalmology operation -- carrying out -- **** -- a disease (affected part) -- red and which different green wavelength (color) -- coincidence -- or also when using it, switching, for a certain reason, it is convenient that the outgoing radiation of the wavelength from which plurality differs with one equipment can be carried out. By the way, the wavelength adjustable laser therapeutic device mentioned above is a gas or die laser, and since there are many problems -- that a laser tube is a short life, needing great power, and equipment is enlarged -- the laser equipment by solid state laser in which a multi-wavelength oscillation is possible is studied. Wavelength selection components, such as prism and a grating, are conventionally inserted into a resonator in such a background, and the method of performing wavelength selection is proposed. Moreover, there are some to which outgoing radiation of two or more laser beams is carried out by switching an output mirror on a resonance optical axis so that it may be indicated by JP,10-65238,A.
[0003]
[Problem(s) to be Solved by the Invention] However, when choosing wavelength by insertion of the former prism etc., the loss in a resonator becomes comparatively large and the conversion efficiency from excitation light to a laser beam becomes low. A high precision is required of the prism itself, its arrangement location, etc. further again. Moreover, in the approach of switching the latter output mirror, in the case of the laser equipment which is made to oscillate a second harmonic and obtains the laser beam of many wavelength, the number of optics which need exchange, such as a non-line type crystal, an output mirror, etc. for obtaining a second harmonic, increases, and there is also a problem that reservation of the alignment precision of each optic at the time of resonance is difficult.
[0004] This invention makes it a technical technical problem to offer the laser equipment in which outgoing radiation is possible for the laser beam of the wavelength from which plurality differs efficiently, making easy reservation of the alignment precision at the time of a wavelength change in view of the above-mentioned trouble.
[0005]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, it is characterized by equipping this invention with the following configurations.
[0006] (1) Set the laser beam of the wavelength from which plurality differs to the laser equipment in which outgoing radiation is possible. While resonating the 1st peak wavelength of the peak wavelength emitted from the excitation light source, the solid-state-laser medium which emits two or more peak wavelength by the light from this excitation light source, and this solid-state-laser medium The 1st resonance optical system with the 1st wave sensing element for oscillating the second harmonic of the 1st peak wavelength as the 1st laser beam, The movable reflective mirror the optical path between said solid-state-laser media and 1st wave sensing elements which have been arranged at this 1st resonance optical system inserts [mirror], While sharing the resonance optical path by the side of said solid-state-laser medium in said 1st resonance optical system by insertion to the optical path of this movable reflective mirror It is

characterized by having the 2nd resonance optical system with the 2nd wave sensing element for oscillating the second harmonic of the 2nd different peak wavelength from said 1st peak wavelength emitted from a solid-state-laser medium as the 2nd laser beam.
(2) In the laser equipment of (1), it is characterized by having arranged the output mirror which has the property which penetrates the wavelength of said 1st laser beam and the 2nd laser beam while reflecting said 1st and 2nd peak wavelength in the optical path of the 1st resonance optical system shared with said 2nd resonance optical system.
(3) In the laser equipment of (2), it is characterized by said solid-state-laser medium using the crystal of Nd:YAG.
(4) Set the laser beam of the wavelength from which plurality differs to the laser equipment in which outgoing radiation is possible. While having the resonance mirror of the pair which resonates the 1st peak wavelength of the peak wavelength emitted from the excitation light source, the solid-state-laser medium which emits two or more peak wavelength by the light from this excitation light source, and this solid-state-laser medium The 1st resonance optical system with the 1st wave sensing element for oscillating the second harmonic of the 1st peak wavelength as the 1st laser beam, The movable reflective mirror which is a movable reflective mirror put on the 1st location and 2nd location possible [a change] in the optical path between said solid-state-laser media and 1st wave sensing elements, and constitutes said 1st resonance optical system when switched to the 1st location, While sharing the resonance optical path by the side of said solid-state-laser medium of said 1st resonance optical system When said movable reflective mirror is switched to the 2nd location The second harmonic of the resonance mirror which is the 2nd resonance optical system by which the resonance optical path of dedication was formed in the reflective direction, and resonates the 2nd different peak wavelength from said 1st peak wavelength emitted to this exclusive optical path from said solid-state-laser medium, and said 2nd peak wavelength is made into the 2nd laser beam. It is characterized by having the 2nd resonance optical system by which the 2nd wave sensing element for oscillating has been arranged.
(5) In the laser equipment of (4), said movable reflective mirror is a movable reflective mirror switched to said the 1st location and 2nd location by being moved in the direction of a resonance optical axis of said solid-state-laser medium, and it is characterized by to establish the exclusive optical path of said 1st and 2nd resonance optical system in the reflective direction of said drive reflective mirror in which a location is switched by this migration, respectively.
(6) said movable reflective mirror is the movable reflective mirror switched to said the 1st location and 2nd location by rotating to the circumference of the shaft of the shaft which intersects perpendicularly with the resonance optical axis of said solid-state-laser medium, and a location is characterized in the reflective direction of a change ****** drive reflective mirror by this rotation in the laser equipment of (4) by ****** in which the exclusive optical path of said 1st and 2nd resonance optical system is prepared, respectively.
(7) In the laser equipment of (4), when the resonance optical path of said 1st resonance optical system inserts, said movable reflective mirror It is the movable reflective mirror switched to said the 1st location and 2nd location. When removed from the resonance optical path of said 1st resonance optical system, said 1st resonance optical system is constituted, and when a movable reflective mirror is inserted in the resonance optical path of said 1st resonance optical system, it is characterized by forming the exclusive optical path of said 2nd resonance optical system in the reflective direction.
(8) (4) In which laser equipment of - (7), it is characterized by having arranged the output mirror which has the property which penetrates the wavelength of said 1st laser beam and the 2nd laser beam while reflecting said 1st and 2nd peak wavelength in the optical path between said solid-state-laser medium and said drive reflective mirror.
[0007]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. Drawing 1 is the external view of the laser photocoagulator for ophthalmology which uses a slit lamp. Drawing 2 is the optical system and the control-system schematic diagram of equipment.
[0008] 1 is a body of laser equipment and a part of light guide optical system for carrying out the light guide of the laser oscillation machine 10 and laser beam which are mentioned later to the affected part of a patient eye, and irradiating them, and control-section 20 grade are contained. 2 is the control section of equipment and the various switches for carrying out the setting input of wavelength selection switch 2a and the laser radiation conditions which choose the wavelength of a laser beam are formed. 3 is a foot switch for sending the trigger signal of laser radiation.
[0009] 4 is a slit lamp and it has a part of observation optical system for observing a patient eye, and light guide optical system. 5 is a fiber for carrying out the light guide of the laser beam from a body 1 to the slit lamp 4. 6 is a stand for moving the slit lamp 4 up and down.
[0010] drawing 2 -- it is, and 10 is a laser oscillation machine and the interior is equipped with the Nd:YAG crystal (only henceforth a rod) 11 which is a solid-state-laser medium, the semiconductor laser (only henceforth LD (Laser Diode)) 12 which is the excitation light source, the nonlinear crystal (only henceforth NLC (Non Linear Crystal)) 13a-

13c which is a wavelength converter, total reflection mirrors (only henceforth HR (High Reflector)) 14a-14f, and the output mirror 15. In addition, as nonlinear crystal, a KTP crystal, an LBO crystal, a BBO crystal, etc. are usable, and the KTP crystal is used with this operation gestalt.

[0011] A Nd:YAG crystal emits light with two or more oscillation lines (peak wavelength) of a near-infrared region by the excitation light from the excitation light source. So, with the equipment of this operation gestalt, outgoing radiation of the with a colors (about 532nm (green), about 561nm (yellow), and about 659nm (red)) of three laser beam is carried out by generating the second harmonic in the oscillation line which is three which are about 1064nm with a high output, about 1123nm, and about 1319nm among two or more oscillation lines using nonlinear crystal.

[0012] HR14a is prepared in the end of the optical path of the optical axis L1 with which a rod 11 is arranged, and the output mirror 15 leans only a predetermined include angle to the other end, and is prepared in it. Although HR14a has the property of total reflection to the wavelength of 1064nm - 1319nm, it may not restrict to this and you may have the property that the wavelength of the infrared region containing the wavelength of 1064nm, 1123nm, and 1319nm is reflected widely. The output mirror 15 has the property which penetrates 532nm - 659nm while carrying out total reflection of the wavelength of 1064nm - 1319nm. On the optical axis L2 of the reflective direction of the output mirror 15, NLC13a and HR14d are fixed and it is prepared. To the wavelength of 1319nm, NLC13a is arranged so that the wavelength of 659nm which is the second harmonic may be generated. HR14d has the property of total reflection to 1319nm and 659nm. Namely, what is necessary is just to give the reflection property which carries out total reflection of the 1319nm of the oscillation line of a Nd:YAG crystal, and enlarges the reflective loss of wavelength with gain higher than it to HR14d for oscillating a 659nm laser beam, while carrying out total reflection of the 659nm.

[0013] It is possible to carry out outgoing radiation of the 659nm of the second harmonic which the 1st resonance optical system which has the resonator structure of a pair where HR14d on HR14a of an optical axis L1 and an optical axis L2 counters on both sides of a rod 11, by such optical arrangement is constituted, and is generated by NLC13a from the output mirror 15, without being prevented with a rod 11.

[0014] Between the output mirror 15 on an optical axis L2, and NLC13a, HR14e is arranged possible [insertion and detachment]. HR14e has the property of total reflection to 1064nm and 532nm. On the optical axis L3 of the reflective direction of HR14e, NLC13b and HR14b are prepared fixed. To the wavelength of 1064nm, NLC13b is arranged so that the wavelength of 532nm which is the second harmonic may be generated. HR14b has the property of total reflection to 1064nm and 532nm as well as 14e. That is, it has the property which carries out total reflection of at least 532nm and the 1064nm in HR14b for oscillating a 532nm laser beam.

[0015] When HR14e is inserted on an optical axis L2 by such optical arrangement, HR14a of the 1st resonance optical system, a rod 11, and the output mirror 15 are shared, and the 2nd resonance optical system from which HR14a and HR14b become the resonator of a pair on both sides of a rod 11 is constituted.

[0016] Between the locations and NLC13a which insert [e / HR14] on an optical axis L2, HR14f is arranged possible [insertion and detachment]. HR14f has the property of total reflection to 1123nm and 561nm. On the optical axis L4 of the reflective direction of HR14f, NLC13c and HR14c are prepared fixed. To the wavelength of 1123nm, NLC13c is arranged so that 561nm which is the second harmonic may be generated. HR14c has the property of total reflection to 1123nm and 561nm as well as HR14f. Namely, what is necessary is just to give the reflection property which carries out total reflection of the 1123nm of the oscillation line of a Nd:YAG crystal, and enlarges the reflective loss of wavelength with gain higher than it to HR14c (HR14f) for oscillating a 561nm laser beam, while carrying out total reflection of the 561nm.

[0017] When HR14f is inserted on an optical axis L2 by such optical arrangement, HR14a of the 1st resonance optical system, a rod 11, and the output mirror 15 are shared, and the 3rd resonance optical system from which HR14a and HR14c become the resonator of a pair on both sides of a rod 11 is constituted.

[0018] The control section by which 20 controls each part of equipment based on the signal from the control section 2 or a foot switch 3, and 21a and 21b are driving gears which consist of a motor etc., you insert [e / HR14] on an optical axis L2, and driving gear 21b makes it insert [a / driving gear 21/ f / HR14] on an optical axis L2 in drawing 2 , respectively.

[0019] In order to have the above configurations, when changing each resonance optical system which has resonator structure, migration etc. does not have to carry out other optical members that what is necessary is just to insert [HR / 14e and 14f]. For this reason, the alignment gap by migration of an optical member can be suppressed to the minimum. Moreover, since the die length between each resonator can be designed freely in such a configuration, arrangement (die length between resonators) of the optical system in which an efficient oscillation is possible can be set up easily the whole resonator.

[0020] In addition, although it drew so that insertion and detachment of HR14e by driving gears 21a and 21b and HR14f

might be moved in an optical axis L3 and the L4 direction in drawing 2 , respectively, as for this, it is desirable to make it move in the direction which intersects perpendicularly with the space of drawing 2 . In this case, it becomes possible to secure alignment precision, without being influenced by the precision of the migration location of HR14e and HR14f.

[0021] Next, based on the above configuration, the approach of carrying out outgoing radiation of the laser beam of the wavelength from which plurality differs is explained.
[0022] The <outgoing radiation approach of 659nm laser beam> way person makes the color (wavelength) of the laser beam used for an operation red (659nm) by wavelength selection switch 2a. At the time of red selection, HR14e and HR14f are placed out of an optical axis L2. Outgoing radiation control of a laser beam uses a foot switch 3, and is performed by giving the trigger signal of outgoing radiation to a control section 20.
[0023] If a trigger signal is received, a control section 20 will carry out the seal of approval of the current to LD12, and will excite a rod 11 by LD12. In addition, AR (Anti Reflective) coating is performed to the both-ends side of the Nd:YAG crystal which is a rod 11 so that permeability may be raised to 1064nm, 1123nm, and 1319nm.
[0024] If a rod 11 is excited, between HR14a and HR14d, 1319nm light will resonate and wavelength conversion will be carried out by NLC13a further arranged on an optical axis L2 at the 659nm light which is the 2nd higher harmonic. The obtained 659nm laser beam penetrates the output mirror 15, and a light guide is carried out to a fiber 5. And it irradiates towards a patient eye from exposure opening of the slit lamp 4.
[0025] The <outgoing radiation approach of 532nm laser beam> way person makes the color (wavelength) of the laser beam used for an operation green (532nm) by wavelength selection switch 2a. A control section 20 makes driving gear 21a drive, and locates HR14e on an optical axis L2 (refer to drawing 3). Moreover, by the trigger signal from a foot switch 3, a control section 20 carries out the seal of approval of the current to LD12, and excites a rod 11.
[0026] If a rod 11 is excited, between HR14a and HR14b, 1064nm light will resonate and wavelength conversion will be carried out by NLC13b further arranged on an optical axis L3 at the 532nm light which is the 2nd higher harmonic. The obtained 532nm laser beam penetrates the output mirror 15, and a light guide is carried out to a fiber 5. And it irradiates towards a patient eye from exposure opening of the slit lamp 4.
[0027] The <outgoing radiation approach of 561nm laser beam> way person makes the color (wavelength) of the laser beam used for an operation yellow (561nm) by wavelength selection switch 2a. A control section 20 makes driving gear 21b drive, and locates HR14f on an optical axis L2 (when the wavelength of 532nm is chosen by the last outgoing radiation at this time, HR14e is evacuated from on an optical axis L2). Moreover, by the trigger signal from a foot switch 3, a control section 20 carries out the seal of approval of the current to LD12, and excites a rod 11.
[0028] If a rod 11 is excited, between HR14a and HR14c, 1123nm light will resonate and wavelength conversion will be carried out by NLC13c further arranged on an optical axis L4 at the 561nm light which is the 2nd higher harmonic. The obtained 561nm laser beam penetrates the output mirror 15, and a light guide is carried out to a fiber 5. And it irradiates towards a patient eye from exposure opening of the slit lamp 4.
[0029] As mentioned above, a with a different wavelength (659nm (red), 532nm (green), and 561n (yellow)) laser beam is obtained. Here, in the reflection property of HR14d for oscillating a 659nm laser beam, it is desirable about the oscillation line by the side of the short wavelength of 1123nm or less with gain higher than 1319nm of the oscillation line of a Nd:YAG crystal to consider as 50% or less of reflection factor. About a 1064 morenm oscillation line, it is desirable to consider as 20% or less of reflection factor.
[0030] Similarly, in the reflection property of HR14c (HR14f) for oscillating a 561nm laser beam, it is desirable about the oscillation line by the side of the short wavelength of 1115.9 or less nm with gain higher than 1123nm of the oscillation line of a Nd:YAG crystal to consider as 50% or less of reflection factor. About a 1064 morenm oscillation line, it is desirable to consider as 20% or less of reflection factor. In addition, what is necessary is to arrange the wavelength selection components 30, such as an etalon, between NLC13c and HR14f, as shown in drawing 4 , and just to constitute 1123nm possible [ejection] alternatively, when it is not easy to establish the difference of a reflection factor by the reflection property of HR14c to 1123nm since 1115.9 nm of the oscillation lines of a Nd:YAG crystal is near in wavelength.
[0031] Although he is trying to constitute the 2nd and 3rd resonance optical system from an operation gestalt explained above by inserting a total reflection mirror (HR14e, HR14f) in the optical path of the 1st resonance optical system, the change which does not restrict to this and is shown in drawing 5 and drawing 6 is also possible.
[0032] First, the example of a change of drawing 5 is explained. What has attached the sign shown by drawing 1 and drawing 4 and the same sign has this function, and explanation is omitted.
[0033] It is a total reflection mirror (HR) with the same reflection property as HR14a, and 14g is arranged with the predetermined include angle on the shaft L2. Moreover, HR14g can move now in a shaft L2 top by driving gear 21c

which consists of driving means (for example, pulse motor etc.) which can detect the amount of drives. For this reason, the resonance optical system for making the laser beam of wavelength which is [reflector / that] different by making it located, respectively in HR14g on the intersection of shafts L3, L4, and L5 and a shaft L2 output can be constituted, respectively. That is, when the reflector of HR14g is located in the intersection location of a shaft L2 and a shaft L5, the resonance optical system used as the resonance mirror of the pair located on both sides of rod 11 grade by HR14a and HR14d is constituted, and the laser beam which is 659nm is obtained. When the reflector of HR14g is located in the intersection location of a shaft L2 and a shaft L4, the resonance optical system which obtains 561nm is constituted. the resonance optical system which obtains 532nm when the reflector of HR14g is located in the intersection location of a shaft L2 and a shaft L3 -- **** -- last ** The optical path of the shafts L3, L4, and L5 which exist in the reflective direction of a shaft L2 is made into the resonance optical path of dedication, respectively.

[0034] Moreover, in the optical system shown in drawing 5 , both the shafts L3, L4, and L5 are set up so that it may become parallel (arrangement). Therefore, what is necessary is just to move [centering on a shaft L2 top], without changing the installation include angle of HR14g, when constructing the resonator in each wavelength respectively using HR14g. For this reason, it becomes easy to secure [of alignment precision] reservation of alignment precision that what is necessary is to take care only about the migration on a shaft.

[0035] In addition, 22a and 22b are a limit sensor for determining the location used as migration criteria of HR14g while detecting the motion limit community of HR14g. In order to form a resonator, when carrying out drive control of the location of HR14g, once a control section 20 moves HR14g to the power up of laser equipment using driving gear 21c to the location detected in limit sensor 22a (or 22b), it makes the location a criteria location. Only the amount of drives beforehand determined to the location (intersection of a shaft L2 and shaft L3-5) where the wavelength of the laser beam chosen is outputted moves HR14g.

[0036] Furthermore, after moving HR14g to the location where the wavelength of the laser beam chosen as mentioned above is outputted to improve outgoing radiation effectiveness of a laser beam, a sensor without the illustration prepared in the output side of the output mirror 15 detects the output of a laser beam. Next, HR14g is made to move slightly forward and backward in accordance with a shaft L2, and HR14g is moved to a location where the output of a laser beam is most highly detected by the sensor. The outgoing radiation of a thereby still more efficient laser beam becomes possible. Moreover, the sensor which detects the output of a laser beam should just use the sensor formed in equipment from the former for output detection of laser equipment.

[0037] Drawing 6 is the change of the angular position of one total reflection mirror, and shows the optical system for carrying out outgoing radiation of the laser beam of three different wavelength. What has attached the sign shown with the above-mentioned operation gestalt here and the same sign has this function, and explanation is omitted.

[0038] It is the driving gear which consists of driving means (for example, pulse motor etc.) which can detect the amount of drives, and the rotation drive of a total reflection mirror (HR) with the 14h of the same reflection properties as HR14a and the 21d of the HR14h can be carried out at the circumference of the shaft of the shaft (shaft perpendicular to space as point A) which intersects perpendicularly with a shaft L2. Control of the amount of drives of 21d of driving gears is performed by the control section 20. In drawing 6 , each shafts L3, L4, and L5 are set up so that it may cross at the intersection A on a shaft L2 altogether, and the reflector of HR14h is located in the location of this intersection A. When the angular position of the reflector of HR14g is switched, the optical path of the shafts L3, L4, and L5 located in the reflective direction is made into the resonance optical path of dedication, respectively.

[0039] In order to form respectively the resonance optical system for carrying out outgoing radiation of the laser beam of each wavelength, when carrying out drive control of the location of HR14h, the rotation drive of the HR14h is carried out to the angular position needed since a control section 20 outputs the wavelength of the laser beam chosen by making the location into the criteria angular position after returning HR14g to the power up of laser equipment at the predetermined angular position using 21d of driving gears. That is, when the angular position of the reflector of HR14h is made in agreement [a change and the reflective direction of a shaft L2] with a shaft L5, the resonance optical system from which HR14a and HR14d serve as a resonator of a pair on both sides of rod 11 grade is constituted, and the laser beam which is 659nm is obtained. the resonance optical system which obtains 561nm when it is made in agreement [the reflective direction of a shaft L2] with a shaft L4 -- **** -- last ** the resonance optical system which obtains 532nm when it is made in agreement [the reflective direction of a shaft L2] with a shaft L3 -- **** -- last ** In addition, what is necessary is to use the limit sensor mentioned above and just to detect the angular position of HR14h, in order to double HR14h with the predetermined angular position (criteria angular position).

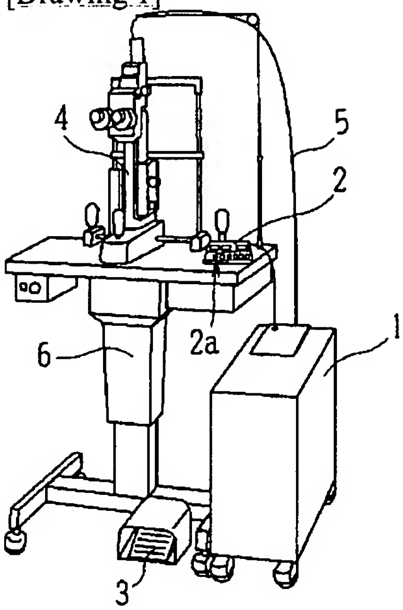
[0040] Furthermore, what is necessary is to use the sensor which detects the output of a laser beam, as mentioned above, and just to tune HR14h finely to whenever [position angle / by which the output of a laser beam is detected most highly] to improve outgoing radiation effectiveness of a laser beam.

[0041] With the operation gestalt explained above, although three waves are made into selection and the thing which carries out outgoing radiation, it does not restrict to this, and it can choose and outgoing radiation of two or more wavelength, such as two waves and four etc. waves, can be carried out. Moreover, what is necessary is just to set each resonance optical system which consists of HR14a, HR14b and HR14a, HR14c and HR14a, and HR14d as the die length of the optical arrangement for which it was suitable for every wavelength, respectively.
[0042]
[Effect of the Invention] As mentioned above, since the optical member made to drive at the time of wavelength selection was stopped to the minimum according to this invention, an alignment gap is controlled. Moreover, since it is not necessary to arrange prism etc. in a resonator, the outgoing radiation effectiveness of a laser beam is high. Furthermore, the die length of the optical arrangement between the resonators which were suitable for every wavelength can be set up respectively.

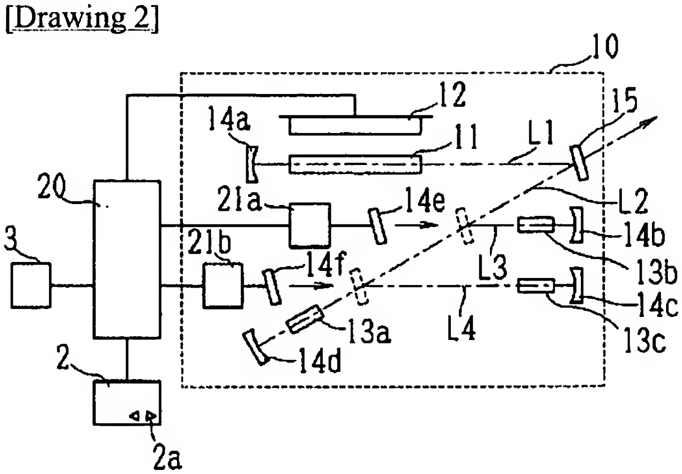
[Translation done.]

DRAWINGS

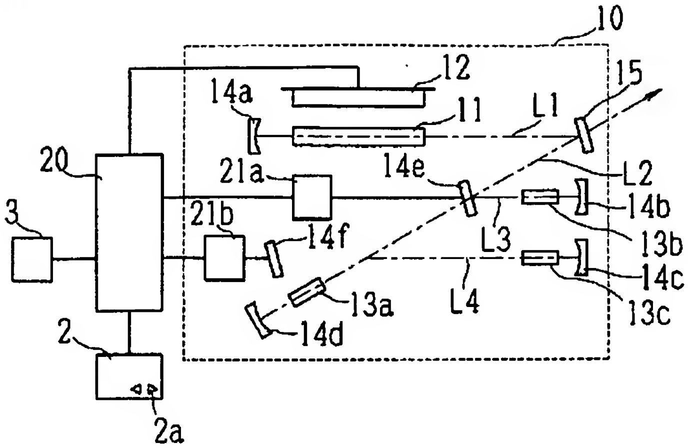
[Drawing 1]



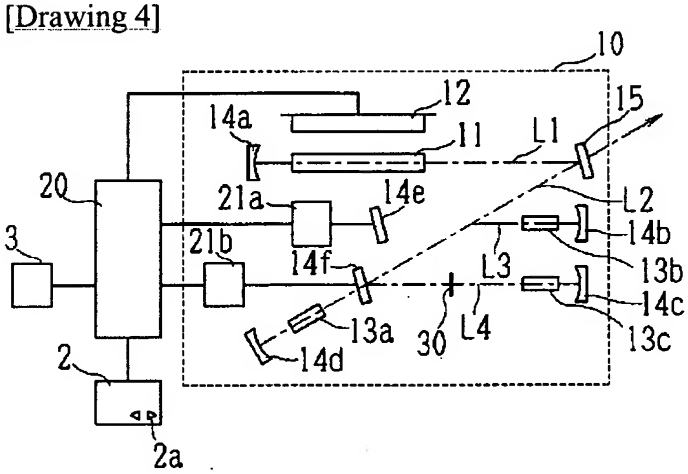
[Drawing 2]



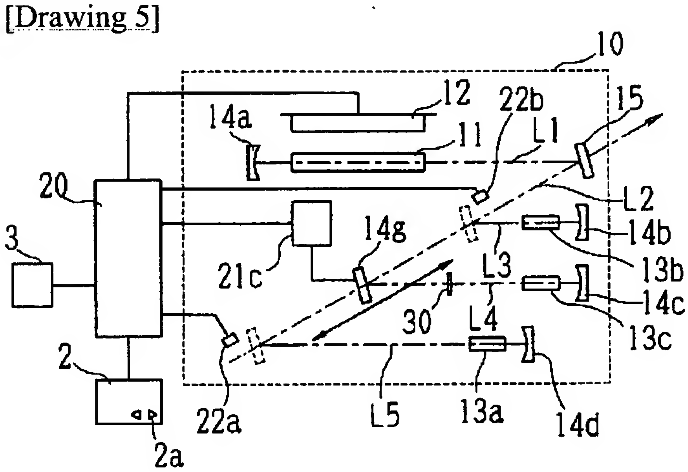
[Drawing 3]



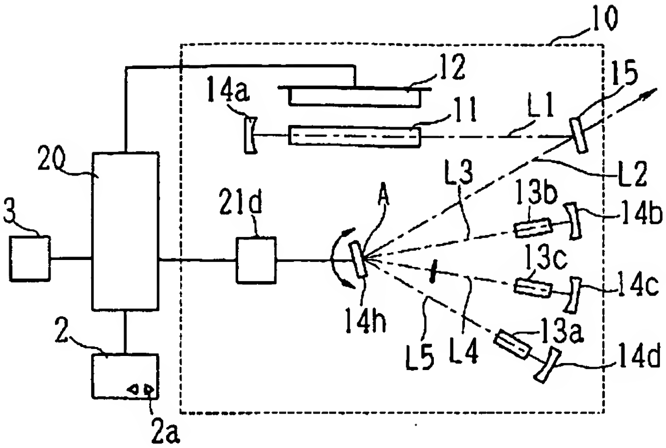
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]